80. A method according to Claim 77, wherein relative movement is effected between the deposition apparatus and the surface so as to move said operating zone across the surface during formation of the masking pattern.

81. A method according to Claim 77, wherein the local environment of the operating zone is controlled so as to control the coalescence of the droplets on the surface.

82. A method according to Claim 77, wherein the local environment of the operating zone is controlled so as to control the spreading of the droplets on the surface.

83. A method according to Claim 77, wherein the local environment of the operating zone is controlled so as to control placement of the droplets on the surface.

84. A method according to Claim 77, wherein the local temperature of the operating zone is controlled so as to control the rate of solidification of the droplets on the surface.

85. A method according to Claim 77, wherein the local atmosphere of the operating zone is controlled.

86. A method according to Claim 85, wherein an at least partial vacuum is generated in the operating zone so as to substantially avoid contamination of the droplets during passage from the deposition apparatus to the surface.

87. A method according to Claim 85, wherein a pressure differential extending between the deposition apparatus and the surface is established in the operating zone.

88. A method according to Claim 85, wherein an inert or reactive gas is introduced into the operating zone during droplet deposition.

89. A method according to Claim 77, wherein the duration of the local exposure of the operating zone to electromagnetic radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

90. A method according to Claim 77, wherein the intensity of electromagnetic radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

91. A method according to Claim 77, wherein the operating zone extends to the surface, and local exposure of the operating zone to electromagnetic radiation is carried out subsequent to the deposition of droplets passing through the operating zone.

92. A method according to Claim 91, wherein the time period between the deposition of droplets on the surface and said local exposure is controlled so as to control spreading of the droplets on the surface.

93. A method according to Claim 92, wherein said time period is in the range from 1 to 2000 ms.

94. A method according to Claim 93, wherein said time period is in the range from 50 to 300 ms.

95. A method according to Claim 77, wherein said electromagnetic radiation is emitted from a source integral with said deposition apparatus.

96. A method according to Claim 95, wherein said electromagnetic radiation is emitted from a plurality of sources spaced along the deposition apparatus.

97. A method according to Claim 77, wherein the electromagnetic radiation comprises at least one of ultra violet, visible light, infra red, microwaves and alpha-particles.

98. A method according to Claim 77, wherein multiple wavelengths of electromagnetic radiation are co-incident sequentially or in parallel on the deposited droplets.

99. A method according to Claim 77, wherein the electromagnetic radiation is emitted from at least one light emitting diode.

100. A method according to Claim 99, wherein the electromagnetic radiation is emitted from an independently addressable array of light emitting diodes.

101. A method according to Claim 77, wherein the electromagnetic radiation is emitted from a semiconductor quantum-well solid state laser.

102. A method according to Claim 101, wherein the electromagnetic radiation is emitted from an independently addressable array of semiconductor quantum-well solid state lasers.

103. A method according to Claim 77, wherein the electromagnetic radiation is emitted from at least one light emitting polymer.

104. A method according to Claim 103, wherein the electromagnetic radiation emitted from said light emitting polymer is filtered to select a particular wavelength of electromagnetic radiation.

105. A method according to Claim 77, wherein the electromagnetic radiation is emitted from a microwave initiated gaseous discharge radiation source.

106. A method according to Claim 77, wherein the electromagnetic radiation is emitted from a plurality of optical fibres.

107. A method according to Claim 77, wherein the electromagnetic radiation emitted is focused on the droplets.

108. A method according to Claim 77, wherein, subsequent to the local exposure of the operating zone to electromagnetic radiation, the deposited masking pattern is fully exposed to electromagnetic radiation so as to ensure that the deposited droplets are cured.

109. A method according to Claim 77, wherein the distance between the deposition apparatus and the surface is controlled during droplet deposition so as to control the time taken for a droplet to pass from the deposition apparatus on to the surface.

110. A method according to Claim 109, wherein said distance is in the range from 0.5 to 2 mm.

111. A method according to Claim 110, wherein said distance is in the range from 0.75 to 1.25 mm.

112. A method according to Claim 77, wherein the deposited masking pattern is imaged using imaging apparatus integral with the deposition apparatus.

113. A method according to Claim 77, comprising the step of controlling the surface energy of the surface prior to droplet deposition.

114. A method according to Claim 113, wherein the surface is subjected to at least one of abrasion, polishing, ozone treatment, plasma exposure and surface coating prior to droplet deposition.

B' cont.

115. A method according to Claim 77, wherein the droplets are deposited from a droplet deposition printhead comprising a deposition chamber for housing said deposition material, an outlet nozzle in fluid communication with said deposition chamber, and means for ejecting droplets of deposition material from said deposition chamber through said outlet nozzle.

116. A method according to Claim 115, wherein the droplets are deposited from a plurality of said printheads.

117. A method according to Claim 116, wherein the masking pattern is formed from a plurality of deposition materials, each deposition material being deposited from respective deposition printhead.

118. A method according to Claim 115, wherein the outlet nozzle is selectively covered to substantially prevent entry of electromagnetic radiation into the deposition printhead.

119. A method according to Claim 115, wherein said nozzle is cleaned after ejection of a droplet from said deposition chamber.

120. A method according to Claim 115, wherein said outlet nozzle is selectively covered by a nozzle shutter, said shutter comprising means for cleaning said nozzle.

121. A method according to Claim 120, wherein said outlet nozzle is cleaned by a movable wiper blade attached to said nozzle shutter.

122. A method according to Claim 120, wherein residual deposition material removed from said nozzle by said cleaning means is transferred to a reservoir housed with said deposition printhead.

123. A method according to Claim 77, wherein the surface is disposed on a flexible sheet connected between two reels, said reels being rotated to move the surface relative to the deposition apparatus.

B' cont.

124. A method according to Claim 77, comprising the step of at least partially removing said deposited masking pattern.

125. A method according to Claim 77, wherein said masking pattern is a three-dimensional masking pattern.

126. A method according to Claim 125, wherein said masking pattern comprises a plurality of layers of deposition material, said layers being sequentially deposited on said surface.

127. A method according to Claim 126, wherein each layer has a respective shape.

128. A method according to Claim 125, wherein said masking pattern is formed from a multiplicity of droplets deposited at a plurality of deposition sites on the surface, droplets being deposited at each of said sites in turn.

129. A method according to Claim 77, wherein said masking pattern comprises a solder reflow mask.

130. A method according to Claim 129, wherein said mask is formed from one of silicone, polyimide, polytetrafluoroethylene and epoxy.

131. A method according to Claim 77, wherein said masking pattern is an etching mask.

132. A method according to Claim 131, wherein said etching mask is formed from an organic-inorganic fluid.

133. A method according to Claim 131, wherein said etching mask is formed from one of epoxy, polycarbonate, silicon, polytetrafluoroethylene, polychlorotrifluoroethylene, polyimide, polyisoprene and polypropylenepolystyrene.

134. A method according to Claim 77, wherein said masking pattern is an electrically conductive mask.

135. A method according to Claim 134, wherein said mask is formed from one of carbon-based and metal acetate-based material.

136. A method according to Claim 77, wherein said masking pattern is a decorative masking pattern.

137. A method according to Claim 77, wherein said masking pattern is an ion implantation mask.

138. A method according to Claim 77, wherein said masking pattern is a confinement well mask.

139. A method of forming a spacer pattern on a surface, said method comprising the steps of:

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to a surface to form a spacer pattern, said droplets passing though an operating zone located between the deposition apparatus and the surface; and

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the surface, thereby controlling the solidity of the spacer pattern.

140. A method of forming a circuit pattern on a circuit board, said method comprising the steps of:

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to said circuit board to at least partially fill via holes formed in the circuit board, said droplets passing through an operating zone located between the deposition apparatus and the surface; and

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the circuit board, thereby controlling the filling of the via holes.

141. A method of forming a relief pattern on a surface, said method comprising the steps of

selectively irradiating a charged roller to selectively remove the charge on portions of the roller;

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to the charged portions of the roller, said droplets passing through an operating zone located between the deposition apparatus and the roller;

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the charged portions of the roller, thereby controlling the structure of the pattern formed on the roller; and

transferring the deposited material from the roller on to a surface to form a relief pattern on said surface.

142. A method according to Claim 141, wherein the relief pattern formed on the surface is subsequently heated to effect material coalescence.

143. A method according to Claim 141, wherein the relief pattern formed on the surface is subsequently subjected to radiation curing to effect material coalescence.

144. A method according to Claim 141, wherein the relief pattern comprises an organic electrode.

145. A method according to Claim 141, wherein said relief pattern comprises an opto-electronic device.

146. A method according to Claim 141, wherein the relief pattern comprises a masking pattern.

147. Droplet deposition apparatus comprising a deposition chamber for housing deposition material, an outlet nozzle in fluid communication with said deposition chamber, means for ejecting droplets of deposition material on demand from said deposition chamber through said outlet nozzle on to a surface, means for defining an operating zone through which droplets pass between the outlet nozzle and the surface, and means for locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the surface.

Respectfully submitted,

Steven J. Henry
Reg. No. 27,900
Wolf, Greenfield & Sacks, P.C.
600 Atlantic Avenue
Boston, MA 02210-2211
(617)720-3500

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AMENDED CLAIMS

[received by the International Bureau on 15 January 2001 (15.01.01); original claims 1-78 replaced by new claims 1-76 (9 pages)]

1. A method of forming a masking pattern on a surface, said method comprising the steps of:

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to a surface to form a masking pattern, said droplets passing through an operating zone located between the deposition apparatus and the surface; and

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the surface, thereby controlling the solidity of the masking pattern.

2. A method according to Claim 1, wherein the formation of the masking pattern is controlled so that the masking pattern has predetermined structural properties.

3. A method according to Claim 1 or 2, wherein the operating zone extends from the deposition apparatus to the surface.

4. A method according to any preceding claim, wherein relative movement is effected between the deposition apparatus and the surface so as to move said operating zone across the surface during formation of the masking pattern.

5. A method according to any preceding claim, wherein the local environment of the operating zone is controlled so as to control the coalescence of the droplets on the surface.

6. A method according to any preceding claim, wherein the local environment of the operating zone is controlled so as to control the spreading of the droplets on the surface.

7. A method according to any preceding claim, wherein the local environment of the operating zone is controlled so as to control placement of the droplets on the surface.

8. A method according to any preceding claim, wherein the local temperature of the operating zone is controlled so as to control the rate of solidification of the droplets on the surface.

9. A method according to any preceding claim, wherein the local atmosphere of the operating zone is controlled.

10. A method according to Claim 9, wherein an at least partial vacuum is generated in the operating zone so as to substantially avoid contamination of the droplets during passage from the deposition apparatus to the surface.

11. A method according to Claim 9 or 10, wherein a pressure differential extending between the deposition apparatus and the surface is established in the operating zone.

B' cont

12. A method according to any of Claims 9 to 11, wherein an inert or reactive gas is introduced into the operating zone during droplet deposition.

13. A method according to any preceding claim, wherein the duration of the local exposure of the operating zone to electromagnetic radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

14. A method according to any preceding claim, wherein the intensity of electromagnetic radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

15. A method according to any preceding claim, wherein the operating zone extends to the surface, and local exposure of the operating zone to electromagnetic radiation is carried out subsequent to the deposition of droplets passing through the operating zone.

16. A method according to Claim 15, wherein the time period between the deposition of droplets on the surface and said local exposure is controlled so as to control spreading of

the droplets on the surface.

17. A method according to Claim 16, wherein said time period is in the range from 1 to 2000 ms.

18. A method according to Claim 17, wherein said time period is in the range from 50 to 300 ms.

19. A method according to any preceding claim, wherein said electromagnetic radiation is emitted from a source integral with said deposition apparatus.

20. A method according to Claim 19, wherein said electromagnetic radiation is emitted from a plurality of sources spaced along the deposition apparatus.

21. A method according to any preceding claim, wherein the electromagnetic radiation comprises at least one of ultra violet, visible light, infra red, microwaves and alpha-particles.

22. A method according to any preceding claim, wherein multiple wavelengths of electromagnetic radiation are co-incident sequentially or in parallel on the deposited droplets.

23. A method according to any preceding claim, wherein the electromagnetic radiation is emitted from at least one light emitting diode.

24. A method according to Claim 23, wherein the electromagnetic radiation is emitted from an independently addressable array of light emitting diodes.

25. A method according to any of Claims 1 to 22, wherein the electromagnetic radiation is emitted from a semiconductor quantum-well solid state laser.

26. A method according to Claim 25, wherein the electromagnetic radiation is emitted from an independently addressable array of semiconductor quantum-well solid state lasers.

27. A method according to any of Claims 1 to 22, wherein the electromagnetic radiation is emitted from at least one light emitting polymer.

28. A method according to Claim 27, wherein the electromagnetic radiation emitted from said light emitting polymer is filtered to select a particular wavelength of electromagnetic radiation.

29. A method according to any of Claims 1 to 22, wherein the electromagnetic radiation is emitted from a microwave initiated gaseous discharge radiation source.

30. A method according to any of Claims 1 to 22, wherein the electromagnetic radiation is emitted from a plurality of optical fibres.

31. A method according to any preceding claim, wherein the electromagnetic radiation emitted is focused on the droplets.

32. A method according to any preceding claim, wherein, subsequent to the local exposure of the operating zone to electromagnetic radiation, the deposited masking pattern is fully exposed to electromagnetic radiation so as to ensure that the deposited droplets are cured.

33. A method according to any preceding claim, wherein the distance between the deposition apparatus and the surface is controlled during droplet deposition so as to control the time taken for a droplet to pass from the deposition apparatus on to the surface.

34. A method according to Claim 33, wherein said distance is in the range from 0.5 to 2 mm.

35. A method according to Claim 34, wherein said distance is in the range from 0.75 to 1.25 mm.

36. A method according to any preceding claim, wherein the deposited masking pattern is imaged using imaging apparatus integral with the deposition apparatus.

37. A method according to any preceding claim, comprising the step of controlling the surface energy of the surface prior to droplet deposition.

38. A method according to Claim 37, wherein the surface is subjected to at least one of abrasion, polishing, ozone treatment, plasma exposure and surface coating prior to droplet deposition.

39. A method according to any preceding claim, wherein the droplets are deposited from a droplet deposition printhead comprising a deposition chamber for housing said deposition material, an outlet nozzle in fluid communication with said deposition chamber, and means for ejecting droplets of deposition material from said deposition chamber through said outlet nozzle.

40. A method according to Claim 39, wherein the droplets are deposited from a plurality of said printheads.

41. A method according to Claim 40, wherein the masking pattern is formed from a plurality of deposition materials, each deposition material being deposited from respective deposition printhead.

42. A method according to any of Claims 39 to 41, wherein the outlet nozzle is selectively covered to substantially prevent entry of electromagnetic radiation into the deposition printhead.

43. A method according to any of Claims 39 to 42, wherein said nozzle is cleaned after ejection of a droplet from said deposition chamber.

44. A method according to any of Claims 39 to 43, wherein said outlet nozzle is selectively covered by a nozzle shutter, said shutter comprising means for cleaning said

nozzle.

45. A method according to Claim 44, wherein said outlet nozzle is cleaned by a movable wiper blade attached to said nozzle shutter.

46. A method according to Claim 44 or 45, wherein residual deposition material removed from said nozzle by said cleaning means is transferred to a reservoir housed with said deposition printhead.

47. A method according to any preceding claim, wherein the surface is disposed on a flexible sheet connected between two reels, said reels being rotated to move the surface relative to the deposition apparatus.

B' cont

48. A method according to any preceding claim, comprising the step of at least partially removing said deposited masking pattern.

49. A method according to any preceding claim, wherein said masking pattern is a three-dimensional masking pattern.

50. A method according to Claim 49, wherein said masking pattern comprises a plurality of layers of deposition material, said layers being sequentially deposited on said surface.

51. A method according to Claim 50, wherein each layer has a respective shape.

52. A method according to Claim 49, wherein said masking pattern is formed from a multiplicity of droplets deposited at a plurality of deposition sites on the surface, droplets being deposited at each of said sites in turn.

53. A method according to any preceding claim, wherein said masking pattern comprises a solder reflow mask.

54. A method according to Claim 53, wherein said mask is formed from one of silicone, polyimide, polytetrafluoroethylene and epoxy.

55. A method according to any of Claims 1 to 52, wherein said masking pattern is an etching mask.

56. A method according to Claim 55, wherein said etching mask is formed from an organic-inorganic fluid.

57. A method according to Claim 55, wherein said etching mask is formed from one of epoxy,. polycarbonate, silicon, polytetrafluoroethylene, polychlorotrifluoroethylene, polyimide, polyisoprene and polypropylenepolystyrene.

B' cont

58. A method according to any of Claims 1 to 52, wherein said masking pattern is an electrically conductive mask.

59. A method according to Claim 58, wherein said mask is formed from one of carbon-based and metal acetate-based material.

60. A method according to any of Claims 1 to 52, wherein said masking pattern is a decorative masking pattern.

61. A method according to any of Claims 1 to 52, wherein said masking pattern is an ion implantation mask.

62. A method according to any of Claims 1 to 52, wherein said masking pattern is a confinement well mask.

63. A method of forming a spacer pattern on a surface, said method comprising the steps of:

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to a surface to form a spacer pattern, said droplets

passing though an operating zone located between the deposition apparatus and the surface; and

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the surface, thereby controlling the solidity of the spacer pattern.

64. A method of forming a circuit pattern on a circuit board, said method comprising the steps of:

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to said circuit board to at least partially fill via holes formed in the circuit board, said droplets passing through an operating zone located between the deposition apparatus and the surface; and

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the circuit board, thereby controlling the filling of the via holes.

65. A method of forming a relief pattern on a surface, said method comprising the steps of

selectively irradiating a charged roller to selectively remove the charge on portions of the roller;

using the technique of drop-on-demand printing to deposit from droplet deposition apparatus a plurality of droplets on to the charged portions of the roller, said droplets passing through an operating zone located between the deposition apparatus and the roller;

locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the charged portions of the roller, thereby controlling the structure of the pattern formed on the roller; and

transferring the deposited material from the roller on to a surface to form a relief pattern on said surface.

66. A method according to Claim 65, wherein the relief pattern formed on the surface is subsequently heated to effect material coalescence.

67. A method according to Claim 65, wherein the relief pattern formed on the surface is subsequently subjected to radiation curing to effect material coalescence.

68. A method according to any of Claims 65 to 67, wherein the relief pattern comprises an organic electrode.

69. A method according to any of Claims 65 to 67, wherein said relief pattern comprises an opto-electronic device.

70. A method according to any of Claims 65 to 67, wherein the relief pattern comprises a masking pattern.

71. Droplet deposition apparatus comprising a deposition chamber for housing deposition material, an outlet nozzle in fluid communication with said deposition chamber, means for ejecting droplets of deposition material on demand from said deposition chamber through said outlet nozzle on to a surface, means for defining an operating zone through which droplets pass between the outlet nozzle and the surface, and means for locally exposing the operating zone to electromagnetic radiation so as to control coalescence of droplets on the surface.

72. A method of forming a masking pattern on a surface substantially as herein described.

73. A method of forming a spacer pattern on a surface substantially as herein described.

74. A method of forming a circuit pattern on a circuit board substantially as herein described.

75. A method of forming a relief pattern on a surface substantially as herein described.

76. Droplet deposition apparatus substantially as herein described.

STATEMENT UNDER ARTICLE 19(1) PCT

The subject matter of dependent Claims 13 and 40 have been added to independent Claims 1, 65 to 67 and 73 as originally filed.

Claims 13 and 40 have been cancelled, with the remaining claims being renumbered accordingly.